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ABSTRACT

The two-factor theory proposed concerns familial mental retardation, in which retardation is mild (IQ 50-70) and persons appear clinically normal with no signs of neurological damage. It is stated that persons in this IQ range differ greatly in vocational, social, and other non-scholastic abilities, and that these differences are only slightly related to IQs obtained by standardized tests. Children of low SES status are seen to show the greatest discrepancy between non-academic abilities and their low IQs. Two broad types of mental ability are delineated: Level I, the non-academic skills (non-transformational learning and retention), and Level II, the academic (intelligence, i.e., analytic understanding, reasoning, abstraction, conceptual thinking). Level II includes the processes generally measured by intelligence tests. Retarded low SES children are found to be superior in Level I ability to middle SES children of similar IQ. Level I and II abilities in the general population are analyzed, as are the nature of the relationship between the Levels, and the physiological basis of Level I and II abilities. (KW)

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A Two-Factor Theory of Familial Mental Retardation

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Varieties of Mental Retardation

Persons who are validly classified as mentally retarded are a highly diverse group. Not only is there great variety in the behavioral and emotional characteristics of the retarded, or in their social adaptability, but careful examination reveals marked difference among them even in their mental abilities, both quantitatively and qualitatively. The causes of mental retardation, as well as their behavioral manifestations, are also diverse. It is our task scientifically to understand this diversity.

Two broad categories of mental deficiency are now generally recognized. The first is comprised of those conditions resulting from (a) chromosomal anomalies (e.g., Down's syndrome or "Mongolism"); (b) major gene defects whereby a single mutant gene, usually recessive, completely overrides the normal determinants of mental development (e.g., phenylketonuria and microcephaly), (c) brain damage due to infectious disease or trauma (e.g., maternal rubella, encephalitis, eclampsia). The vast majority of the most severely retarded, with IQs below 50, belong in this category.

The second category consists of what is now called familial mental retardation. The vast majority of these individuals are mildly retarded, with IQs between 50 and 70. (The upper limit seems quite arbitrary and has been placed anywhere from 70 to 85). At least 80 to 90 percent of persons in this IQ range appear clinically normal and show no history or signs of neurological damage.

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The first category of retardation, although it is continuous with the normal distribution of intelligence in the population, is in a sense separate from it. It is superimposed upon the normal distribution and creates the "bulge" at the lower tail of the distribution, that is, the excess over the frequency of low IQs that would be expected from a polygenic and microenvironmental model of the distribution of intelligence in the population.

The second category of retardation, that is, the so-called familial variety, on the other hand, can be viewed as just the lower tail (about 3 percent) of the normal distribution. Although such retardation constitutes normal variation rather than a pathological condition, for the individual it is usually a severe handicap educationally, occupationally, and socially. Such persons as adults in a modern industrial society can seldom manage on their own and they usually require various social services for their welfare.

The relative frequency of this "normal," aclinical kind of retardation increases drastically as we move from higher to lower socioeconomic segments of the population. But it is worth noting that when the mean IQ of all individuals within any given stratum of the population (or a random sample thereof) is determined, this information alone permits a considerably accurate estimate of the frequency of familial retardation within that segment of the population. (The same thing holds true in predicting the frequency of intellectually gifted persons in a given segment of the population.) It is clear that there is a highly lawful relationship between the overall mean IQ of a population (or subgroup thereof) and the frequency of familial retardation (and of giftedness) in that population. This is even more true when we consider only the children in a population group rather than the parental generation, which, with the high degree of social

mobility found in modern Western societies, has already become quite sorted out along occupational and socioeconomic lines, creating markedly skewed IQ distributions of the adult populations of the upper and lower SES groups. These quite lawful relationships to which I have just referred are best described in terms of the properties of the normal curve, and they are highly consistent with a polygenic theory of the distribution of intelligence. Mental retardation of the second kind, therefore, cannot properly be regarded in isolation from parameters of the intelligence distribution in the whole population. Some theories of the etiology of mental retardation and the programs proposed for its amelioration all too often overlook this central fact.

Heterogeneity of Abilities in Familial Retardation

From here on I shall be concerned only with the aclinical variety of mental retardation, which accounts for at least 80 percent of all mental deficiency. Although individuals in this category span a range of 20 or 30 IQ points and differ in predictable ways as a result, there are actually greater ability differences within this group than one might expect on the basis of IQ differences alone. Indeed, retarded persons having the very same IQ are often seen to differ quite markedly in their abilities, and to differ in ways that do not seem entirely accountable in terms of differences in their experience and training. Children and adults in the IQ range from 50 to 80 are known to differ greatly in vocational aptitudes, in social adaptability, and in various non-scholastic aptitudes, and these differences are only slightly related to their IQs obtained on the best standard tests. What these persons share most in common is an inordinate difficulty in regular school work. Under the usual conditions of class instruction, they lag far behind the average child of the same age, and the gap increases from

earlier to later years. In non-academic pursuits, on the other hand, these children show great diversity of ability. I have been concerned with understanding the basis for this diversity. Although my present conclusions have taken shape gradually throughout a series of empirical studies, it will be most efficient to begin by presenting the main points of my formulation as it now stands.

The Basic Observations

There are several inter-related empirical observations which my theoretical formulation attempts to explain.

First, there is the fact that retarded children in the IQ range between 50 and 80 are a relatively homogeneous group in performance on practically all standard intelligence tests. Most individual tests, such as the Stanford-Binet and the Wechsler scales have their highest reliability and concurrent validity in this range of the IQ distribution.

Second, there is the fact that within this rather homogeneous group with respect to IQ, there is apparently a very much greater range of other abilities, including cognitive abilities, provided they are non-academic in the traditional sense of the word. These abilities have been noted in the casual observations of parents, teachers, school psychologists, and the like, as great differences in the acquisition of skills on the playground, in social skills, and in practical knowledge and shrewdness in coping with the environment.

Third, there is the fact that children of the lowest socioeconomic status (SES), who comprise by far the largest proportion of the aclinical mentally retarded, show the greatest discrepancy, on the average, between their low IQs and these other kinds of abilities I have referred to. This seems especially true of Negro children of low SES. Middle-class white

children with low IQs, on the other hand, generally show a more all-round retardation. Their poor performance on IQ tests is more consistent with their general behaviour, in and out of school, than seems to be the case with low SES retarded children, whose mental handicap often seems confined almost entirely to the more academic aspects of schooling.

These casual observations by teachers and school psychologists have contributed largely to the popular belief that the standard IQ tests are somehow culturally biased against children of low SES and in favor of middle-class white children. The tests are seen as seriously underestimating the intelligence of low SES children. The fact that the IQ predicts scholastic performance equally well for low SES as for middle SES children is usually explained away by saying that schooling itself, both the academic curricula and the methods of instruction, is culturally biased in favor of the middle class. Until a few years ago I had subscribed completely to this commonly held viewpoint, and my research in this area actually began with an attempt to formalize these observations in the psychological laboratory and thereby to demonstrate, by more precise and rigorous methods than had yet been applied, that the much higher incidence of retardation among children of low SES, particularly among minority children, was the fault of the IQ tests and also, possibly, of the schools. My own research in this vein has since led me to reject this view. But the theory I have gradually arrived at to replace it is quite different from the simple alternative that existed before I began my research.

In order to analyze the basic observations which I have just described, a series of laboratory studies were conducted in which we compared retarded and average children of lower and middle SES (including Negro, Mexican, and white children) on a number of standard IQ tests and also on a considerable variety of other cognitive tasks. (We were not interested in sensory

and motor skills or other abilities outside the cognitive domain.) These studies have been summarized elsewhere in more detail than is possible here (Jensen, 1968a,b,c; 1969a,b,c; 1970a,b,c; 1971; Jensen & Rohwer, 1968, 1970). What these studies show, aside from any theoretical interpretation, are essentially the following points:

1. On a variety of tests of rote learning and short-term memory, retarded children score much less far below children of average IQ than on tests involving abstraction, reasoning, problem solving, and conceptual learning. Consequently, some considerable proportion of children who are retarded in terms of IQ are able to perform at an average level or above on a certain class of tasks that clearly involve mental ability. These are represented in our laboratory studies by (a) Trial-and-error selective learning with visual and auditory reinforcements for correct responses. (These problems have involved the trial-and-error acquisition of anywhere from 2 to 12 S-R associations.) (b) Serial rote learning, using lists of familiar objects (e.g., cup, comb, pencil, etc.), pictures of familiar objects, colored geometric forms, nonsense syllables, and common nouns. (c) Paired-associates learning, using the same or similar materials as in the serial learning. (d) Free recall learning (e.g., presenting 20 familiar objects and asking the subject to recall, in any order they come to mind, the names of as many of the items as possible when they are put out of sight), using the same materials as above. (e) Digit span memory under different conditions of presentation and recall (e.g., recall immediately after presentation of the string of digits; recall 10-seconds after presentation; and recall after three successive presentations of the same string of digits.

What all these tasks have in common, as contrasted with tasks on which all retardates perform much more poorly, is that they call for little or no transformation of the stimulus input in order for the subject to arrive at the response output. Stimulus and response are highly similar. What the tasks call for essentially is accurate registration of sensory experiences, immediately giving already well-learned names or labels to these, and at some later point in time repeating these labels in response to partial stimulus cues. It is a kind of recording and playback on cue, as contrasted with the other class of cognitive tasks, those on which retardates perform most poorly, involving transformation and mental manipulation of the input in order to produce the answer -- the relating and comparing of present stimuli with past learning, generalization and transfer of old learning to the new problem, the abstraction of conceptual and semantic similarities and differences, etc. All of these latter processes especially characterize those kinds of intelligence test items which are most highly loaded with g, the general factor common to all intelligence tests, which Spearman characterized as an ability for the "eduction of relations and correlates." For convenience I have labelled these two broad types of mental ability Level I (for non-transformational learning and retention) and Level II (for intelligence as characterized by g).

2. Level I and Level II abilities show an interaction with SES such that retarded low SES children are on the average superior in Level I ability to middle SES children of the same IQ. Those retardates who appear most adequate in non-academic activities are generally average or above average in Level I. It is not uncommon, for example, to find low SES Negro children with IQs below 60 who perform in the average range or above on Level I tests. Yet their counterparts in this respect are exceedingly rare among low IQ middle and upper-middle class white children, who almost always perform well

below the average on Level I tests.

Institutionalized retardates (and usually those in "sheltered workshops"), as contrasted with a representative sample of all retardates in the population, are usually low both in Level I and Level II abilities. It is therefore doubtful if my findings would ever have been made had I tested only institutionalized individuals. There are marked differences between retardates who become more or less self-sufficient out in the world and those who must be cared for. Psychometrically this difference is not much related to IQ but is more markedly related to Level I ability.

In attempting to understand these findings, our first thought was that the Level II tests were more culturally biased against low SES individuals and that therefore, for any given IQ, the low SES person was really more intelligent than the high SES person, and this difference would show up in the presumably less culture-biased Level I tests. In short, I at first thought I had found in my Level I tests a culture-free or a culture-fair means of measuring intelligence. But this idea has proved to be wrong. A variety of Level II tests differing in degree of culture-loading all show highly consistent results: We have found no tests, verbal or nonverbal, with any appreciable complexity or substantial g loading on which properly diagnosed retarded children score in the average range. And surprisingly enough, low SES children, especially if they are Negro, actually score slightly higher on the verbal and the more obviously culture-loaded tests than on nonverbal tests of the type that attempt to minimize middle-class cultural content. Also, the experimental manipulation of task variables in laboratory learning experiments so as to either minimize or maximize the role of Level II processes leads me to the conclusion that the Level I - Level II distinction is not a matter of the culture-loading of the tests that measure each type of ability but of the different kinds of mental

processes required in the two classes of tests. Nor is the difficulty of the task the essential basis of distinction. Level I and Level II test items can be made equally difficult in terms of their p values (i.e., the percentage of the population that can perform successfully). The essential distinction between Level I and Level II is in the complexity of the mental transformations required for successful performance on the task. Moreover, twin and sibling correlations and estimates of the heritability (i.e., the proportion of the total variance in test scores attributable to genetic factors) of Level I and Level II tests give no indication of significantly lower heritability of Level II than of Level I tests. If Level II tests reflect environmental or cultural influences to a greater extent than Level I tests, one should expect lower heritability values for Level II tests. But this is not the case, and, if anything, slightly the reverse seems to be true.

Level I and Level II in the General Population

In order to determine just how far below the average of the population retarded children stand on Level I tests, we have given such tests to large, representative samples of the school age population, now totalling 15,000 children in all. And to study the relationship between Level I and Level II abilities, verbal and nonverbal intelligence tests, representative of Level II, have also been administered to the same large samples. These large-scale data obtained from the general population put our findings with the mentally retarded into a proper perspective and show that they are not isolated phenomena peculiar to retardates but are a consequence of certain population characteristics.

The regression of Level I test scores on IQ or Level II scores in all samples appears to be linear throughout the IQ range from about 50 to 150.

The slope of the regression line and the correlation between Level I and Level II abilities differs from one subpopulation group to another. It is lower in low SES groups and higher in upper SES groups. It is especially lower among Negroes as compared with whites. In various studies the correlation between Levels I and II have ranged from.10 to.40 in low SES groups, comprised largely of Negro children, and from.50 to.70 in middle SES groups comprised largely of white children. (However, a sample of Oriental-American children, although of lower SES than the white sample, showed an even higher correlation between Levels I and II than was found in the white sample.) Because the regression of Level I on Level II has a steeper slope (higher correlation) in higher than in lower SES groups, the regression lines of lower and upper SES groups must inevitably cross. Consequently, in the region of low IQ that characterizes mental retardation, the lower SES group obtains higher average scores on Level I tests -- which is the phenomenon described earlier. These relationships are shown in Figure 1.

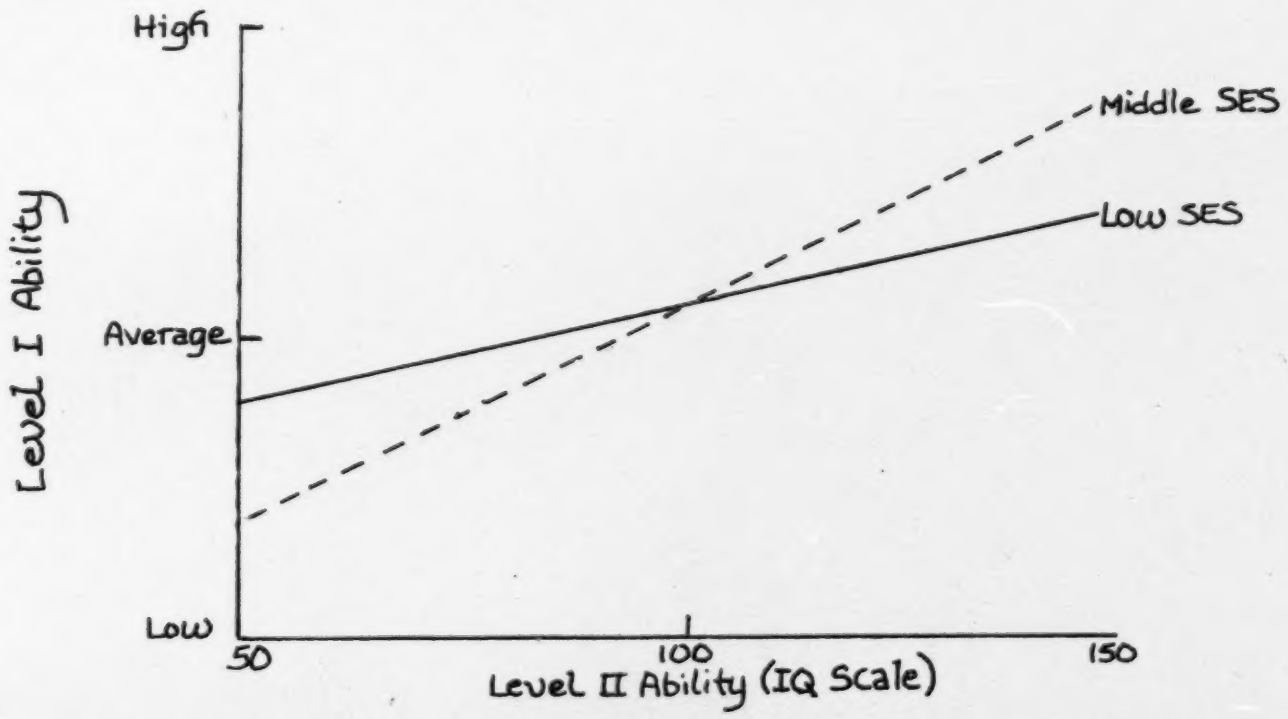

Fig. 1. Typical regression lines of Level I upon Level II ability in middle and low socioeconomic groups.

Thus, the phenomenon of higher Level I ability among lower than among upper SES retardates, on the average, is seen to be a consequence of the lower correlation between Levels I and II in the low SES group as compared with the higher SES group. But what we did not expect to find before we finally tested children in adequately large numbers throughout the entire range of IQ is the reverse phenomenon at the upper end of the IQ scale, that is, the finding that low SES children (most of whom are Negro in these studies) with high IQs perform significantly less well than their middle SES counterparts in IQ. This came as something of a surprise, but it is now based on such substantial evidence that its factual status is beyond reasonable doubt. From a theoretical standpoint it is, of course, a simpler, more lawful picture than we would have if the regression were not linear and the consequent reverse symmetry at the low and high ends of the IQ scale did not obtain.

This finding, furthermore, helps to clarify a point about which there was some doubt in the earlier stages of our research. This was the question of whether low SES retardates performed better on Level I tests, relative to those of middle SES, simply because Level I tests were less culturally biased than the IQ tests. This culture-bias hypothesis seems untenable in view of the fact that in the range of IQ above 100, low SES children perform relatively less well on Level I tests. Also, when we have given various Level II tests which differ obviously in culture loading, such as the Peabody Picture Vocabulary Test and Raven's Progressive Matrices, and then have examined the regression of the less culture-loaded on the more culture-loaded test, we find no cross-over of the regression lines of the low and middle SES groups; the lines are quite parallel. In short, comparison of lower and upper SES groups on Level I vs. Level II

tests gives a quite different picture from that of comparing the two groups on culture-loaded vs. culture-fair tests.

Nature of the Relationship Between Levels I and II

Does the correlation between Level I and Level II abilities represent a functional dependence of Level II upon Level I? For example, is above-average Level I ability a necessary but not sufficient condition for above-average Level II ability in the sense, say, that knowledge of subtraction is a necessary but not sufficient condition for solving problems in long division? Obviously some degree of learning and memory (i.e., Level I ability) are essential for intellectual development. But above some low threshold of Level I ability, is there any functional dependence of individual differences in Level II upon individual differences in Level I? We know, of course, that there is some correlation, often quite substantial, between Levels I and II. But correlation does not necessarily imply functional dependence of one set of processes upon another, in this case Level II upon Level I. This question has puzzled us for some time. It probably cannot be answered definitively on the basis of the evidence now available. A number of lines of evidence, however, suggest a hypothesis that seems most likely to be true.

In the first place, the wide range of correlations between Levels I and II, going from .20 to .80 (after corrections for attenuation and restriction of range) in various subpopulations, seems inconsistent with a high degree of functional dependence between the two types of ability. If the correlation were completely a result of functional dependence, it is difficult to see why the dependency should be so much higher in one population group than in another. Secondly, a high degree of functional dependence

would imply an increasing correlation between Levels I and II with increasing age from early childhood to early maturity, since this is the period of marked development of Level II abilities. But we have found no evidence of greater correlation between Levels I and II with increasing age, and slightly the opposite is the case. Subjects with high IQs but low Level I ability are somewhat less common among younger children between the ages 4 and 7 than among children beyond 10 years of age. It is as if Level I ability acts as scaffolding for the development of Level II abilities and then falls away in importance as the Level II abilities are consolidated. The child who is below average in Level I and above average in Level II will appear to be a slow developer in Level II in early childhood; he is in a sense a slow learner who, because of good Level II ability, is able thoroughly to understand and consolidate everything he learns and incorporate it into the cognitive structures we call intelligence. Later in development these Level II cognitive structures become relatively more important in educational attainments, and the child who is relatively low in Level I but high in Level II becomes much less handicapped in school than the child who shows the opposite pattern of abilities. The low I - high II child is one who learns with difficulty in school when the learning is more or less rote and affords little opportunity to grasp concepts and relationships; he is slow in acquiring skill that requires sheer repetition; but once it has been acquired, he can fully bring to bear what he has learned in logical reasoning and problem solving. He <u>understands</u> what he learns, though he may have learned it slowly. Such children, who often seem to get off to a slow start in the early grades in school, appear to become brighter and intellectually more capable as they progress in school and as the academic subject matter makes increasing demands on conceptual and

abstract thinking and involves relatively less sheer acquisition of simple skills and factual information. The high I - low II child, on the other hand, presents a very different picture. In early childhood he may appear quite bright and quick in picking up all kinds of simple skills and verbal knowledge; he may appear linguistically precocious; he may do quite well in scholastic subjects and skills that depend upon learning by repetition such as penmanship, spelling, mechanical arithmetic, memorizing the words of songs, etc., but he experiences increasing difficulty and frustration -- sometimes to the point of hating school -- as the conceptual and abstract demands of the subject matter increase from earlier to later grades. It becomes increasingly difficult to understand what is learned, and, when ultimately in some academic subjects learning and understanding become one and the same, the pupil with a marked deficiency in Level II is almost totally handicapped. While one can find some small percentage of pupils of below-average Level I ability who are doing very well, say, in algebra or science, there are virtually no below-average Level II pupils who are succeeding in these subjects.

If there is at most only a slight degree of functional dependence of Level II upon Level I, as suggested by the fact that some few older children with high Level II ability are found to be well below-average in Level I, what is the basis for the correlation between Levels I and II and for the fact that it differs so markedly in different populations? The most plausible explanation is in terms of genetic assortment. If Levels I and II are controlled by two different polygenic systems, these can become assorted together to any degree in a given population through selective and assortative mating. I have rejected the idea that only Level I ability is genetically determined and that Level II abilities are learned, acquired, or developed out of Level I abilities entirely as a result of environmental

influences. If this were the case, the heritability of intelligence (Level II) should not be as high as we know it to be -- about 70 to 80 in present-day populations. Also, according to this notion, Level I should have much higher heritability than Level II. But the correlations obtained on siblings and twins give no indication that Level I abilities are significantly more heritable than Level II abilities, and if anything, Level I ability appears less heritable than Level II. It seems much more likely that both Level I and Level II are controlled by distinct polygenic systems and are correlated to varying degrees in different population groups because these groups have differed in the kinds of demands that would cause the genetic factor underlying Levels I and II to become assorted together. We know there is a high degree of assortative mating for intelligence in European and North American Caucasian populations. In fact, in Western society there is probably a higher degree of assortative mating for intelligence than for any other trait.

This should not be too surprising since educational attainments, occupational level, and socioeconomic status, which are the basis for assortative mating, are highly correlated with intelligence. If Level I ability also has some correlation with occupational and socioeconomic status independently of intelligence (Level II), we should expect the genetic factors involved in Levels I and II to become associated through assortative mating. This is consistent with the observation that omnibus-type intelligence tests which involve an admixture of both Level I and Level II (e.g., the Stanford-Binet and Wechsler tests) show a higher correlation with practical criteria such as educational achievement and occupational status than do factorially more pure tests of Level II, such as the Raven Matrices. Populations that

have not long been stratified educationally and occupationally would have had less assortative mating for these abilities, and consequently would show a lower correlation between them, as we find, for example, in the American Negro population as contrasted with the white. Also, Level II ability, being more highly related to the academic and intellectual demands of schooling and higher occupational status is more subject to assortative mating and consequently to genetic stratification in terms of socioeconomic status. Good Level I ability, on the other hand, is more or less equally advantageous in all cultures and walks of life and would therefore become less differentiated than Level II among various population groups.

Physiological Basis of Level I and II Abilities

This is quite speculative, but from what we know about the organization of the nervous system it is an interesting hypothesis that the basic locus of Level I abilities is in the electrochemical processes involved in short-term memory and the neural consolidation of memory traces. The biochemical basis of these processes is evinced, for example, in the fact that learning and memory, which involve neural consolidation, can be altered by pharmacological means. Level II abilities, on the other hand, are hypothesized to depend upon the structural aspects of the brain -- the number of neural elements and the complexity and organization of their potential interconnections.

The evolution of the nervous system, represented in the hierarchy of phyla, is most evident in the development of Level II processes. The growth of mental ability in the individual similarly reflects largely the

gradual emergence of Level II processes from infancy to maturity (Jensen, in press). G. Stanley Hall's famous dictum that "ontogeny recapitulates phylogeny" appears to hold true for mental as well as physical development. The growth curves of Level I and II are quite different, with Level I approaching its developmental asymptote at an earlier age than Level II.

Theoretical Overview

The picture is that of a fundamental division of mental abilities into Level I (learning and memory) and Level II (intelligence, i.e., analytic understanding, reasoning, abstraction, conceptual thinking). Individual differences in both Levels I and II are viewed as due mainly to independent polygenic factors. The distributions of Level I and II abilities in the population are approximately normal. The correlation between Levels I and II is due mainly to the common assortment of the genes involved in the two types of ability. (But there is also some moderate degree of functional dependence of Level II upon Level I.) The genetic correlation differs in various subpopulations, being lower in the low SES segment of the population and higher in the middle and upper-middle class segment. The correlation is lower in the American Negro than in the white population. Because education makes greater demands on Level II than on Level I and the occupational hierarchy and socioeconomic status are highly related to educational attainments in Western societies, there is a much greater mean difference between social classes in Level II than Level I. While Level I is distributed about very similar means in lower and upper SES groups, the means of the Level II distributions may differ by one standard deviation or more. (One standard deviation is equivalent to about 15 IQ points.)

Mental retardation of the type which is a part of the normal distribution of abilities in the population can be described as primary retardation if it

involves marked deficiency in both Levels I and II and as secondary retardation if there is a deficiency only in Level II ability. Secondary retardates often appear normally bright and capable of learning and achievement in many situations, although they invariably experience great difficulties in school work under the traditional curricula and methods of instruction. Many secondary retardates who are regarded as backward children while in school later become socially and economically adequate persons once they are out of the academic situation. Primary retardates, on the other hand, appear to be much more handicapped in the world of work. A serious shortcoming of ordinary IQ tests is that they measure predominantly Level II and fail to distinguish between primary and secondary retardation. Tests that reliably measure both Levels I and II should be developed for use in schools, in personnel selection, and in the armed forces. This formulation also has important implications for the education of children now popularly called culturally disadvantaged, most of whom have normal Level I ability but are often quite far below average in Level II. Such children might benefit educationally from instructional methods which make the acquisition of scholastic skills less dependent upon Level II abilities and more fully engage Level I abilities as a means of raising their educational attainments.

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